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Impact of sustainability pedagogies on pre-service teachers' self-efficacy

Abstract

Purpose - Education for Sustainability (EfS) espouses student-centred, transformative pedagogies that promote learning through active, participatory and experiential learning. Yet, traditional lectures provide limited opportunities for engaging students in such pedagogies. This article recounts the inclusion of sustainability pedagogies within the constraints of a traditional lecture, to investigate the effect on pre-service teachers' self-reported EfS self-efficacy.

Design/methodology/approach - A quasi-experimental, pre-post test design with a non-randomised control group was applied. Lectures in the treatment group adopted sustainability pedagogies, in addition to the more traditional teaching methods employed in both groups.

Findings - While a significant improvement was observed in pre-service teachers' EfS self-efficacy in both groups, there is no evidence to suggest that the inclusion of sustainability pedagogies is more effective for enhancing pre-service teachers' EfS self-efficacy than traditional, teacher-centred pedagogies alone. Participants reported that an increase in their knowledge and understanding of sustainability concepts most strongly influenced their EfS self-efficacy.

Practical implications - This study informs the teaching and learning of EfS within and beyond higher education, as well as other wider university teaching practices.

Originality/value - There is a scarcity of research into sustainability pedagogies and, particularly, the effect of sustainability pedagogies on students' learning. This study explores the implementation and effect of embedding sustainability pedagogies within the constraints of a lecture mode of course delivery that is applicable beyond the field of Education.

Keywords - Education for Sustainability, environmental education, teacher education, pre-service teacher education, pedagogy, sustainability pedagogies, pre-service teacher self-efficacy.

Article classification - Research paper

Introduction

With sustainability being a key consideration for governments and societies globally (Martin et al., 2007), there is a greater necessity than ever before to integrate Education for Sustainability (EfS - also referred to as Environmental or Sustainability Education, and Education for Sustainable Development) into teaching and learning in higher education. How best to go about this is an important research focus (Fien and Rawling, 1996; Knapp, 2000; Lin, 2002; Tilbury, 1992). To date, most work has focused on curriculum change and course development, while pedagogy, an equally important aspect, has been largely overlooked (Thomas, 2004; Thomas, 2009). The research presented in this paper begins to address this research gap through a study that trialed and evaluated

the effect of implementing sustainability pedagogies on pre-service teachers' EfS self-efficacy, described here as a pre-service teacher's belief that he or she can teach EfS effectively (Moseley et al., 2002). Self-efficacy is an important measure in this context because self-efficacy beliefs influence the amount of effort people are willing to expend on a given task, the length of time people will persist with a task in the face of barriers, as well as levels of resilience and the accomplishments that people achieve (Bandura, 1997).

The university in which this research is situated, similar to others around the world, typically delivers on-campus courses through traditional two-hour lectures delivered to whole cohorts of students (up to 250 students), and one-hour tutorials with much smaller class sizes (up to 30 students). While teacher-centred lectures are recognised as effective for presenting information to large numbers of people, they are limited in their capacity to positively influence learners' understanding, thinking and capacity to act for sustainability (Sterling, 2012). Instead, sustainability scholars espouse student-centred transformative pedagogies that promote learning through active, participatory and experiential learning approaches (Sterling, 2004; Cotton and Winter, 2010; Bosselmann, 2001). Referred to as 'sustainability pedagogies' by EfS scholars (Cotton and Winter, 2010; Sterling, 2012), examples include role-plays and simulations, group discussions, stimulus activities, debates, critical incidents, case studies, reflexive accounts, personal development planning, critical reading and writing, problem-based learning, and fieldwork (Cotton and Winter, 2010). However, despite much enthusiasm, there is a lack of published empirical research to support the implementation of sustainability pedagogies (Christie et al., 2012; Cotton et al., 2009; Dyball and Carpenter, 2006).

This paper reports on the process, methods and outcomes of embedding such pedagogies into the lecture component of a core, foundational (first-year) EfS course for pre-service teachers. Outcomes of the study focus on pre-service teachers' reported levels of self-efficacy to teach EfS after participating in the course. Below we foreground this study by providing a brief history of EfS in pre-service teacher education, and review the literature regarding the impact of sustainability education programs on pre-service teachers' self-efficacy, before outlining the context of our research.

EfS in Pre-service Teacher Education

Calls to include EfS in pre-service teacher education can be traced through conferences, initiatives and scholarly publications to the early 1970s (see Fien and Tilbury, 1996; Tilbury et al., 2005). A lack of progress by the late 1990s stimulated the establishment of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) Chair on Reorienting Teacher Education to Address Sustainability in 2000 (UNESCO, 2010). The chair provides advice to UNESCO and

teacher education institutions. It established an international network of 75 institutions from 60 countries to incorporate EfS into programs, practices and policies, and developed a set of guidelines and recommendations for reorienting teacher education which were used to build the foundation of the most recent initiative, the Decade of Education for Sustainable Development (DESD) from 2005 to 2014 (United Nations Educational, Scientific and Cultural Organisation [UNESCO], 2010; United Nations Educational, Scientific and Cultural Organisation [UNESCO], 2005). The aim of the DESD was to promote sustainable development within education broadly, as well as to encourage and report on innovative EfS curricular and pedagogical reform within pre-service teacher education (see Tilbury, 2011; Wals, 2012). Despite years of international support for the inclusion of EfS in pre-service teacher education, there is overall uncertainty about the extent to which it is actually integrated (Wals, 2009); however, stand-alone courses are the most commonly-reported method by which EfS is included in pre-service teacher education programs (e.g., Hegarty et al., 2011; Kennelly and Taylor, 2007).

EfS is underpinned by student-centred pedagogical principles and practices, including open-ended, participatory and interactive processes involving transdisciplinary inquiry and experiential approaches realised through, for example, group discussions, debates, role-plays and simulations, stimulus activities, and case studies (Christie et al., 2012; Sterling, 2008; Sterling, 2012; Cotton and Winter, 2010). Although there is increasing evidence to suggest that sustainability pedagogy is “simply good pedagogy” (Higher Education Funding Council for England [HEFCE], 2008, p. 34), research suggests that such practice within higher education is aspirational rather than actual (Cotton et al., 2009). This is because, despite extensive theorisation of best-practice, there is little empirical evidence to guide academics wishing to adopt such strategies (Dyball and Carpenter, 2006; Cotton et al., 2009); hence, our interest in studying the process and impact of implementing sustainability pedagogies at our university. The premise underlying this research is that EfS represents a major shift in the way students are taught and learn within higher education (Dawe et al., 2005) and, therefore, requires academics to consider a different view of pedagogy (Sterling, 2004).

Environmental/Sustainability Education: Outcomes for Pre-service Teachers’ Self-efficacy

Only a handful of researchers have investigated the effect of environmental education programs on the self-efficacy of pre-service teachers. A first study in 1992 (Sia, 1992) found that pre-service teachers have negative self-efficacy beliefs related to teaching environmental education due to insufficient knowledge, training and skills. Since then, a few other researchers have studied the effect of environmental education programs on the self-efficacy of pre-service teachers (Krantz, 2002; Gardner, 2009; Moseley et al., 2002; Moseley et al., 2003; Richardson et al., 2014). Findings

are mixed. For example, Moseley et al.'s (2002, 2003) evaluation of a three-day outdoor environmental education program found no change in pre-service teachers' self-efficacy beliefs arising from their participation in the program; however, students' self-efficacy dropped significantly seven weeks post intervention. Richardson et al.'s (2014) study examined the outcome of a two-year environmental education intervention and found that pre-service teachers' self-efficacy beliefs increased over the first half of the intervention, and then decreased towards the end. The lack of consistent findings points to the complex nature of teaching and learning. Although positive self-efficacy is recognised as fundamental to effective teaching, the most effective way to develop positive self-efficacy towards teaching environmental and sustainability education, as supported by the research literature, is vague.

Research Context

Pre-service teachers enrolled in the Bachelor of Education (Primary, Early Childhood and Middle School majors) at James Cook University (JCU) are required to undertake a course entitled *Foundations of sustainability education* in the first year of the program. The course is delivered via three modes of delivery: 'internal' (i.e. on-campus in Townsville, Cairns and Singapore), 'external' (i.e. off-campus for students studying the Early Childhood Education online program), and a community-based delivery for Indigenous Australian pre-service teachers.

The course draws upon the natural and social sciences to provide an introduction to the principles and practices of EfS through a series of six modules that explore contemporary sustainability issues related to human population growth and urbanisation; water resource management; renewable and non-renewable energy resources; sustaining biodiversity; food security and sustainable agriculture; stratospheric ozone depletion and global warming. As well as face-to-face delivery of subject material via weekly lectures and tutorials, teaching and learning in the course is supported by a customised online learning platform embedded within JCU's learning management system that is accessed by all pre-service teachers. Each of the six online modules are framed through an inquiry framework that guides learners to tune into the weekly topic, engage with explicit learning of new material, reflect on their learning, and consider implications for personal and classroom practice. While mass weekly lectures tend to be dominated by direct teaching and transmissive-style pedagogies, smaller tutorials offer an opportunity for pre-service teachers to engage in more hands-on and experiential pedagogies that model classroom practice.

The focus of this study is the 2013 internal cohort of pre-service teachers from two of JCU's campuses. Since the introduction of *Foundations of sustainability in education* in 2010, the content and delivery of the course across the different campuses and modes has been aligned in accordance with JCU policy that requires that students receive an equivalent learning experience regardless of

where or how they are enrolled. Different pedagogies can be employed to suit varying contexts; however, which has provided us (the course lecturers on two of JCU's campuses) with a unique opportunity to introduce sustainability pedagogies in the weekly lecture on one campus and compare the experience of the two groups. Given that *Foundations of sustainability in education* provides pre-service teachers with their first, sustained engagement with EfS in the Bachelor of Education, we were interested to learn whether adopting more sustainability pedagogies in the lectures would impact positively on their EfS self-efficacy, with a view to adopt such pedagogies more widely and move away from a more didactic lecture. We acknowledge that the first-year pre-service teachers in this study have had very limited classroom experience (i.e., only five days of practicum for those who commenced their studies at the beginning of the year, or none for mid-year entrants); therefore, any research that explores their self-efficacy for engaging with or teaching EfS is limited to their early perceptions of what classroom teaching might be like. Nonetheless, other studies have shown that positive attitudes towards EfS can be an important precursor for further positive engagement with EfS (e.g., Miles et al., 2006; Lane et al., 1995).

Methods

This study employed a quasi-experimental, pre-post test design with a non-randomised control group to consider the effects of implementing sustainability pedagogies on pre-service teachers' EfS self-efficacy. Lectures for the control group were delivered in the same way as they had been done in previous years. These lectures were dominated by transmissive-style pedagogies; that is, through direct delivery and explanation of the subject material, and punctuated with short online videos, revision and summary exercises, and science demonstrations. Lectures for the treatment group covered the same content and included the transmissive-style pedagogies as the control group; however, additional sustainability pedagogies (as per Cotton and Winter, 2010) were used to teach selected concepts, as determined by the authors. This included embedding activities into the weekly lectures based on futures thinking, case studies, stimulus activities, discussions, and critical reading. Examples of activities undertaken are outlined in Table 1, which explains a selection of pedagogies that were employed in both the control and treatment groups and additional sustainability pedagogies that were employed in the treatment group only. Both cohorts participated in 13 weekly lectures during Semester 2, 2013. The intervention was administered from Week 2 to Week 12. Participants completed a survey pre- and post-intervention during the Week 1 and 13 lectures to assess pre-service teachers' levels of self-efficacy related to teaching EfS before and after participating in the course (see *Research Instrument*).

Place Table 1 about here

Research Participants and Process

While all students participated in lectures through their normal enrolment in *Foundations of sustainability in education*, a sample of 162 pre-service teachers consented to participate in the research, including 92 (57%) in the control group and 69 (43%) in the treatment group. Participants were advised of the research and invited to participate one week prior to commencement of the course via the learning management system and email. Time was allocated at the end of the first lecture to provide an overview of the nature and goals of the research, answer any questions and invite pre-service teachers to participate. Given that we were working in the role of teacher-researchers, the authors vacated the lecture theatre and a research assistant obtained informed consent, and administered and collected the survey, to respect participants' anonymity in accordance with the project's human ethics approval. For this reason, participant codes were used to facilitate data analysis.

Research Instrument

The instrument used for this study is based on Sia's (1992) *Environmental Education Efficacy Belief Instrument*, comprising questions that examine two constructs, EfS teaching self-efficacy belief and EfS teaching outcome expectancy, using a five-point Likert scale (strongly agree, agree, uncertain, disagree, strongly disagree). 'EfS teaching self-efficacy' refers to a pre-service teacher's belief in their own capability to teach EfS, while 'EfS teaching outcome expectancy' refers to a pre-service teacher's belief that he or she can influence student learning. Sia's (1992) instrument is a modification of Enochs and Riggs' (1990) *Science Teaching Efficacy Beliefs Instrument*. For the purpose of this study, we modified Sia's (1992) instrument to include demographic questions and four open-ended questions in each (pre- and post-test) survey, designed to enable us to more deeply probe differences between the two study groups. Given that our study involves first-year pre-service teachers, we felt it was more appropriate to focus on EfS self-efficacy (as a precursor for further positive engagement with EfS), adopting the position that it is too early in the participants' teacher education program to appreciate fully their potential influence on student learning (i.e., their teaching outcome expectancy). For this reason, we discuss data pertaining to pre-service teacher EfS teaching self-efficacy only.

The survey comprises three sections. The first section elicits demographic data about respondents, including yes-no questions about their high school science education, and whether they have previously taught EfS or environmental education. The second section comprises 23 statements about teaching EfS, 13 of which examine the construct of self-efficacy (e.g., I

understand EfS concepts well enough to be effective in teaching EfS; I wonder if I will have the necessary skills to teach EfS). All items require a response according to a 5-point scale, as outlined above. Responses were coded from 1 (*strongly disagree*) to 5 (*strongly agree*), such that higher scores correspond to greater self-efficacy, and were standardised by reverse-scoring the negatively worded questions. The third and final section of the survey comprises four open-ended questions that invite respondents to comment on particular aspects of *Foundations of sustainability in education* (see *Data analysis* section below).

The validity of Sia's (1992) instrument was determined to be high by two independent groups of researchers. This includes a panel of academics from a variety of disciplines, who undertook an analysis of the instrument (see Sia, 1992), and Moseley et al. (2002), who determined a Guttman split-half coefficient of 0.9132. Based on the instrument's validity and reliability, as established by Sia (1992) and Moseley et al. (2002), we felt assured that the scale was appropriate to measure pre-service teachers' self-efficacy in this study. In the current study, the EfS self-efficacy subscale (13 items) appeared to have good internal consistency, Chronbach's $\alpha = 0.78$.

Data Analysis

In total, across both sites, 162 participants completed the pre-test survey and 131 participants completed the post-test survey. However, only 88 post-test responses from the first and second sections of the survey could be matched to the pre-test surveys (43% response rate), and 87 participants responded to one or more of the open-ended questions in the third section (refer Table 3). Therefore, data analysis was performed on matched (Sections 1 and 2) and available participant responses (Section 3) using a combination of quantitative and qualitative techniques.

Demographic data were analysed using univariate analysis (percentage, means and standard deviation). Repeated measures between-within analysis of variance (ANOVA) was performed to test for any significant differences between the pre-service teachers' pre-test and post-test EfS self-efficacy in the control and treatment groups. Independent and paired samples *t*-tests were conducted to investigate any significant interactions identified by the repeated measures ANOVA analysis. Due to the number of analyses, a Bonferroni-adjusted significance level of 0.017 was calculated to account for the increased possibility of type-1 error. *Pearson's* correlation and an independent sample *t*-test were conducted to compare previous education and teaching experience with pre- and post-test scores. The possible range of composite scores for the teaching efficacy belief scale was 13 to 65 (*Mdn* = 39).

The open-ended responses from Section 3 were analysed through qualitative content analysis as per Berg (2007). The purpose of the analysis was to compare how pre-service teachers'

self-reported learning differed between the control and treatment groups by examining their responses to the open-ended survey items that asked participants to comment on:

- Aspects of the course that pre-service teachers appreciated;
- Self-identified changes to pre-service teachers' knowledge, skills and attitudes to teaching EfS as a result of participation in the course;
- Self-identified aspects of the course that influenced pre-service teachers' confidence to teach EfS; and
- Pre-service teachers' self-identified comfort levels with the thought of teaching EfS in schools or early learning centres.

The analysis process involved (a) establishing frames of categorisation from the open-ended survey questions; (b) developing grounded categories for sorting the data by reading the answers to the open-ended survey questions and identifying any emergent themes or categories that were relevant to the research questions; (c) determining objective criteria of selection for sorting the data chunks into the analytic and grounded categories by developing a categorisation matrix; (d) sorting the data into the various categories; and (e) counting the number of entries in each category to illustrate the frequency of participants' responses.

Research Findings

In the sections that follow, we present the findings of our research. The first section outlines the results of the quantitative analysis of Sections 1 and 2 of the survey (i.e., participants' demographic data, and the EfS self-efficacy items). The second presents findings pertaining to the qualitative analysis of Section 3 of the survey (i.e., pre-service teachers' self-reported learning and self-efficacy beliefs, and their relationship to their experience of the course). While, overall, a significant improvement in pre-service teachers' EfS self-efficacy was observed in both the treatment and control groups, there was no significant difference between the groups. In other words, in the context of our study, it appears that both approaches to teaching EfS (i.e., the adoption of sustainability pedagogies and more teacher-centred pedagogies) are equally effective in enhancing pre-service teachers' EfS self-efficacy. For pre-service teachers in both the treatment and control groups, it was an increase in their knowledge and understanding of sustainability concepts that most strongly influenced their EfS self-efficacy. We provide evidence in support of these findings below.

Quantitative Results: Pre-service Teachers' EfS Self-efficacy

Of the matched surveys (N=88), 38 pre-service teachers comprised the treatment group and 50 pre-service teachers comprised the control group. Females represented 88% of all pre-service teacher

participants. Participant age ranged from 17 to 53 years. The average age of respondents in the treatment group was slightly higher in the treatment group than the control group (24 years and 20 years, respectively). Participants were enrolled in the following education majors: Early Childhood Education (23%), Primary Education (74%), and Middle School Education (3%).

For Section 2 of the survey, repeated measures univariate analyses of variance were conducted to explore the possible impact of two independent variables (i.e., time¹ and group) on one dependent variable (i.e., pre-service teachers' EfS self-efficacy). In exploring participants' EfS self-efficacy, a significant main effect was found for time, $F(1, 86) = 63.85, p < 0.001$, partial $\eta^2 = .42$, which indicates that pre-service teachers' self-efficacy scores varied from pre- to post-test. A significant time*group interaction was also observed, $F(1, 86) = 7.11, p = 0.009$, partial $\eta^2 = .08$, which suggests that pre-service teachers' scores for both groups varied from pre- to post-test. As indicated by partial η^2 , a moderate proportion of the variance in pre-service teachers' self-efficacy scores (i.e., 42%) was attributable to the pre-test to post-test condition. The time*group interaction accounted for 8 per cent of the variance in self-efficacy scores. No significant effects were found for group.

Across both groups, pre-service teachers' mean EfS self-efficacy composite scores reflected moderate self-efficacy levels at pre-test (treatment group $M=42.5$, control group $M=40.83$; Table 2). A paired samples t -test found a significant improvement in respondents' EfS self-efficacy from pre- to post-test for both the treatment group, $t(37) = -5.09, p < 0.001$, and the control group, $t(49) = -6.87, p < 0.001$ (Table 2). An independent samples t -test found no significant difference between the control and treatment groups' EfS self-efficacy scores at pre-test, $t(93) = 1.30, p = 0.19$, and no significant difference in the groups' post-test scores, $t(91) = -1.96, p = 0.053$.

Place Table 2 about here

There were no significant associations between the treatment and control group of pre-service teacher participants' post-test EfS self-efficacy scores and number of years of secondary school science education, secondary school extracurricular science activities or previous experience teaching EfS, environmental education or science. Age was not correlated with EfS self-efficacy scores.

Qualitative Results: Pre-service Teachers' Self-reported Learning and Self-efficacy Beliefs

¹ "Time", as it was used in the context of this analysis, refers to the difference in the means on the dependent variables from pretest to posttest, rather than the actual time that elapsed.

Results from Section 3 of the survey (open-ended questions) are shown in Table 3. Even though the response rates to this section of the survey are low and statistically insignificant, the emergent grounded categories do reflect a number of similarities and differences, which we report below in relation to each question, and explore in the final discussion.

Place Table 3 about here

Aspects that pre-service teachers appreciated about the course.

Analysis of aspects that respondents reported appreciating most about *Foundations of sustainability in education* resulted in four grounded categories: the modularised structure of the course; the topics, information and content covered; the tutorials; and the teaching style and strategies used (Table 3). Of the four aspects cited by pre-service teachers, teaching style and strategies employed was identified most frequently; however, almost half of the respondents in the treatment group nominated this aspect (48.8%), compared to a little over a quarter of respondents in the control group (27.3%). The topics, information and content examined in the course was also frequently identified as being appreciated by respondents, but in this case, it was the control group who cited this aspect almost twice as much as the treatment group (45.4%, compared to 25.5%).

Changes to knowledge, skills and attitudes to teaching EfS as a result of participating in the course.

Analysis of pre-service teachers' self-reported changes to knowledge, skills and attitudes about teaching EfS found that approximately 64% of pre-service teachers in both the treatment and control groups most frequently identified an increase in their knowledge of sustainability and related concepts as a result of participating in *Foundations of sustainability in education* (Table 3). Some pre-service teachers also cited an improvement in their attitudes towards EfS; a greater proportion belonging to the control group than the treatment group (28.6% compared to 16.1%).

Aspects of the course that influenced pre-service teachers' confidence to teach EfS.

Of the total number of survey respondents, 108 (87%) indicated that their participation in *Foundations of sustainability in education* positively influenced their confidence to teach EfS (i.e., 82% in the treatment group, and 92% in the control group). For the majority of respondents, a reported increase in their knowledge and understanding of sustainability concepts most strongly influenced their confidence to teach EfS (treatment group 74.1%, control group (66.7%) (Table 3). A small number pre-service teachers also cited the pedagogical strategies modelled in the course and the tutorial activities as being important influences on their EfS self-efficacy.

Pre-service teachers' comfort levels with the thought of teaching EfS in schools or early learning centres.

Some similarities and differences in pre-service teacher self-reported comfort levels with the thought of teaching EfS in schools or early childhood learning centres were found between the two groups (Table 3). A similar proportion of pre-service teachers in the treatment (45.4%) and control group (48.9%) reported feeling comfortable with the thought of teaching EfS in schools or early childhood learning centres; however, a much larger proportion of pre-service teachers in the control (20.4%) compared to the treatment group (3.0%) reported feeling more comfortable than they did before completing the course. Slightly more pre-service teachers in the treatment (33.3%) than control group (26.5%) reported feeling 'somewhat comfortable' at the thought of teaching EfS, while a much greater proportion of respondents reported feeling not very comfortable in the treatment group (18.2%) compared to the control group (4.0%).

Discussion and Conclusions

With a view to embed more active, student-centred sustainability pedagogies in traditional mass lectures, this research sought to investigate the effect of implementing such pedagogies on pre-service teachers' EfS self-efficacy beliefs through a quasi-experimental, pre-post test design. Our findings revealed that pre-service teachers' EfS self-efficacy improved following their participation in *Foundations of sustainability in education*. This is a favourable outcome that is likely to positively influence their future engagement with EfS as they move through their pre-service teacher education program. At the same time, we did not find any significant differences in EfS self-efficacy between the group that experienced sustainability pedagogies and the group that did not. Overall, most pre-service teachers reported an increase in their confidence to teach EfS as a result of participating in the course, regardless of the pedagogical experience (treatment group 82%, control group 92%). Participants attributed this change largely to an increase in their knowledge and understanding of sustainability issues, which aligns with other studies that have found that higher levels of subject knowledge are associated with heightened levels of teacher self-efficacy (e.g., Woolfolk Hoy and Davis, 2006).

These results must be interpreted with caution; however, as the treatment group did not exclusively experience sustainability pedagogies during the lectures. Like the control group, this group also experienced some traditional, teacher-centred instruction of key sustainability concepts. The sustainability pedagogies were limited to an additional teaching and learning activity in 11 of the 13 lectures. Given this, perhaps it is not surprising that no significant difference was found in pre-service teachers' EfS self-efficacy between the two groups. Nevertheless, these results do suggest that including some sustainability pedagogies in mass lectures is equally effective for

developing pre-service teachers' EfS self-efficacy as more traditional lectures dominated by teacher-centred instruction alone. It could be the case that in the context of a foundational course in pre-service teachers' first-year experience, students appreciate more explicit, direct teaching of core concepts so as to develop their conceptual base, which may evolve to include more student-centred instruction as they transition into the later years of their program (Kift, 2009).

Qualitative analysis of pre-service teachers' free responses to the survey questions revealed some expected differences, as well as more ambiguous and contradictory differences, between the groups. For example, more pre-service teachers in the control group (45.5%) compared to the treatment group (25.6%) reported they most appreciated the topics, information and content examined in the course, while a greater proportion of pre-service teachers in the treatment group (48.8%) compared to the control group (27.3%) reported they most appreciated the teaching style and strategies used. These findings appear to be consistent with the respective pedagogical approaches applied (i.e., teacher-centred delivery of content versus more student-centred approaches). We were surprised to find; however, that more pre-service teachers in the control group (16.7%) compared to the treatment group (9.7%) identified that greater levels of pedagogical knowledge positively influenced their confidence to teach EfS. While it is not clear why this might be the case, it is important to remember that the survey asked questions about pre-service teachers' experience of the course more broadly, and not the lectures alone. There are a number of aspects of the course that engage pre-service teachers with pedagogical knowledge, including the online modules, tutorials and assessment tasks. Furthermore, there are a number of variables that may have impacted the pre-service teachers' learning experience, including differences in the teaching experience and subject knowledge of the lecturing staff; and differences in learning environments and resources. It may also be too early in pre-service teachers' university studies for them to make meaningful connections between course content, pedagogy and future teaching. Nonetheless, a small number of pre-service teachers (treatment group 9.7%, control group 16.7%) identified knowledge of pedagogical strategies as the aspect of the course that most influenced their confidence to teach EfS; so it appears that, overall, pedagogical knowledge is not a significant factor that influenced the EfS self-efficacy of the pre-service teachers in this study. In summary, findings indicate that although pre-service teachers in the treatment group appreciated the teaching style and strategies used, these had no greater impact on pre-service teachers' self-reported confidence to teach EfS than more teacher-centred approaches alone. In reality, increased content knowledge had the greatest effect on pre-service teachers' self-efficacy.

This finding concurs with previous research that could not attribute a direct link between pre-service teacher self-efficacy and purposefully designed environmental education interventions (Moseley et al., 2003; Moseley et al., 2010; Richardson et al., 2014), but differs from broader

related research that suggests active over passive instructional strategies are more effective for increasing personal teaching efficacy (Nietfeld and Cao, 2005; Narayan and Lamp, 2010). Also important to consider; however, is that, in accordance with Avery and Meyer (2012), students do not benefit uniformly from any type of instruction.

Overall, our experience highlights the complex and multi-faceted nature of teaching, learning and associated student attributes such as self-efficacy. Our findings and speculation about what may have transpired have lead us to raise a number of questions about the role of content knowledge and pedagogy in enhancing pre-service teacher self-efficacy: How are content knowledge and pedagogy related to one another in terms of pre-service teacher self-efficacy? How can content knowledge and pedagogy be leveraged to enhance pre-service teacher self-efficacy? To what extent do other variables need to be considered in examining the critical point between content knowledge and teaching strategies related to pre-service teacher self-efficacy in EfS? We consider asking such questions through rigorous inquiry that builds on to our professional judgement and expertise will help to unravel complex teaching and learning situations such as that presented here.

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